DEPARTMENT OF MINING ENGINEERING

Scheme of Instruction and Syllabus of

M.E. (Mining Engineering)

Full Time

UNIVERSITY COLLEGE OF ENGINEERING

(AUTONOMOUS)

OSMANIA UNIVERSITY HYDERABAD – 500 007, TELANGANA

(With effect from the Academic Year 2021-22)

INSTITUTE

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of mining engineering profession and also contribute to the regional and country's developmental activities. To develop academic and research excellence in Mining and allied areas to solve the various problem in the Industry.

Mission

- To groom students in scientific Mining in various domains of mining and allied areas using advanced technologies.
- To train the human resources with knowledge base in the field of Mining Engineering so that they can face the challenges of Mining Engineering problems to provide viable solutions.
- To integrate their understanding and attainable knowledge on the specializations for effective functioning in their profession and useful to the welfare and safety of mankind and also to impart knowledge about safety, conservation, environmental protection, statutory obligations, economy and social responsibility, utilizing state-of-the-art laboratories.
- To enhance the technical knowledge and research aptitude in the domains of various Mining Engineering specializations to serve the society in highly professional manner.
- Produce highly competent and capable professionals and motivated young academicians to provide solutions to real life problems of Engineering and Technology and has apt for continuous learning and dedication towards societal issues.

- To promote institute and industry connect, focusing on leadership, continuous learning, creativity, professional ethics and involvement in research and consultancy projects.

Programme Educational Objectives (PEO):

1. Impart and enrich knowledge in the fields of mining and earth resources engineering by the application of sound engineering principles
2. Exposure to the state-of-art techniques / knowledge of modeling techniques in to be adopted for different Mining Engineering Problems
3. Facilitate the policy makers and administrators to solve issues pertaining to regional Development using Mining Resources
4. Provide continuing education in the entire value chain of the profession starting from exploration to beneficiation of mineral deposits in a coordinated manner

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Programme Outcomes (PO):

1. Students will be able to solve the mining engineering problems by application of knowledge of basic sciences, engineering, geo-technology, economics, environment & management.
2. Graduates will have the technical skill to design mine excavations and conduct mining operations under a variety of geo-mining environments.
3. Achieve all round optimization of various unit operations of mining, ranging from exploration to beneficiation.
4. Analyze and evaluate the techno-economic feasibility of mining projects and deep understanding of economic and environmental implications of mine design and operations.
5. Students will be fully equipped with skills and knowledge related to mine management, optimization techniques with multi-disciplinary skills for achieving sustainable development of mineral industry.
6. Students shall have in depth knowledge in the entire value chain of the profession starting from exploration to beneficiation of mineral deposits in a coordinated manner.

MAPPING OF PEO'S WITH PO'S

PROGRAMME EDUCATIONAL OBJECTIVES	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6

M. E. MINING ENGINEERING

w. e. f. 2021-22

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	MI 101	Surface Mine Planning and Design	3			30	70	3
Core-II	MI 102	Rock Mechanics and Ground Control	3			30	70	3
Program Elective-I	MI 103	Geo-Statistics	3			30	70	3
	MI 104	Advanced Exploration Techniques						
	MI 105	Advanced Metal Mining And Mechanization						
Program Elective-II	MI 106	Geo-Environmental Engineering	3			30	70	3
	MI 107	Instrumentation in Mining						
	MI 108	Hydraulics and Hydraulic Equipment in Mining						
Audit-I	AC 101	Disaster Mitigation and Management	2			30	70	0
	AC 102	English for Research Paper Writing				30	70	
	AC 103	Sanskrit for Technical Knowledge				30	70	
	AC 104	Value Education				30	70	
MC	CE 100	Research Methodology in Civil Eng.	3			30	70	3
Lab-I	MI 109	Computer Applications in Mining	2			50		1.5
Lab-II	MI 110	Advanced Mining Geology Laboratory	2			50		1.5
		Total	**21**			**270**	**490**	**18**
SEMESTER-II								
Core-III	MI 103	Numerical Modelling in Mining	3			30	70	3
Core-IV	MI 104	Rock Excavation Engineering	3			30	70	3
Program Elective-III	MI 111	Surface Mine Environmental Engineering	3			30	70	3
	MI 112	Modern Surveying Techniques						
	MI 113	Long wall Mining						
Program Elective-IV	CE 311	Ground Improvement Techniques	3			30	70	3
	MI 114	Reliability Engineering						
	MI 115	Finite Element Analysis						
Audit-II	AC105	Personality Development	2	1		30	70	0
	AC106	Stress Management by Yoga						
	AC107	Constitution of India						
Core-V/ MC	MI116	Mini Project			6	50		3
Lab-III	MI 151	Geo-Technical Engineering Laboratory			3	50		1.5
Lab-IV/ Seminar	MI 161	Seminar			3	50		1.5
		Total	**14**	**1**	**12**	**300**	**350**	**18**

SEMESTER-III								
Program Elective-V	MI 113	Advanced Coal Mining And Mechanization	3			30	70	3
	MI 129	Mine Systems Engineering						
	CE 203	Groundwater Engineering						
	CE 215	Models of Air and Water Quality						
Open Elective	OE 903	Industrial Safety	3			30	70	3
	OE 904	Business Analytics						
	OE 905	Waste to Energy						
	OE 906	Intellectual Property Rights						
	OE 907	Composite Materials						
	OE 908	Geospatial Technology						
Core-VI/ MC	MI 381	Major Project Phase-I	6		20	100		10
		Total	**12**		**20**	**160**	**140**	**16**
SEMESTER-IV								
Core-VII/ MC	MI 382	Major Project Phase-II			**32**		**200**	**16**
		Grand Total						**68**

CIE: Continuous Internal Evaluation SEE: Semester End Examination

MI 101

SURFACE MINE PLANNING & DESIGN

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

To learn the advancement of surface mining method.

Course Objectives:

1) To introduce the various techniques for mine planning,
2) geotechnical investigation and equipment management.
3) To appreciate the modern trends in opencast mines, safety and environment

UNIT I

PLANNING **10**

Mine development phases, quality control and conservation. Output and manpower planning; calendar planning, mine scheduling, production scheduling, truck dispatch system, design of sumps and pumping systems and drainage. Feasibility Report - Contents and preparation. Introduction: Stages/Phases of mine life; Preliminary evaluation of surface mining prospects; Mine planning and its importance; Mining revenues and costs, and their estimation; Mine planning components, planning steps and planning inputs. Pit Planning: Development of economic block model; Pit Cut-off grade and its estimation; floating cone technique method.

Production planning: Neccesity of Production Planning, new trends in Production planning, Determination of optimum mine size; Introduction to production scheduling.

EQUIPMENT MANAGEMENT

Selection of mining system vis-à-vis equipment system. Machine availability, productivity, maintenance, maintenance scheduling, preventive maintenance, control and monitoring inventory. Workshops for HEMM. Power supply arrangements in opencast mines.

UNIT II

GEOTECHNICAL PARAMETERS **7**

Application of geotechnical investigation for design of ultimate pit slope and other design parameter, slope failure, types of slope failure, factors effecting slope failures. Selection of initial mine cuts, location of surface structures, division of mining area into blocks, mine design, bench drainage, geometry, slope stability; open pit limits and optimization, Mine Closure plan and its importance, Mine Closure plan contents.

UNIT III

ANALYSIS AND DESIGN OF HIGHWALL SLOPES AND WASTE DUMPS **8**

Influence of pit slope on mine economics; Highwall slope stability analysis and design methodology.

Design of haul roads: Design of road cross section; Design of road width, curves and gradient; Haul road safety features and their design. Design of drainage system.

UNIT IV

SAFETY AND ENVIRONMENT **10**

Safety aspects in opencast mines regarding height, width and slope of benches, drilling and blasting, fly rock, nearby dwellings, mine illumination, gradient and other aspects of haul roads, formation of spoil dumps, tailings management etc. pollution due to noise, vibrations due to machinery and blasting, water pollution, measurement monitoring and control measures for the same, land reclamation and afforestation, environmental audit.

UNIT V

MODERN TRENDS IN OPENCAST MINES **10**

Recent developments in mining methods and layouts. In pit crushing & conveying, continuous surface mining.

Extraction and dumping. Extraction of seams developed/extracted by underground methods.

Placer mining and solution mining – scope of applicability, sequence of development and machinery.

TOTAL: 45 PERIODS

OUTCOME:

1) The students will have insight about the advanced techniques for mine planning,
2) Geotechnical investigation and equipment management
3) Understand the modern trends in opencast mines safety and environment.

REFERENCES

1) Surface Mine Planning by R.T Deshmukh
2) Das, S.K., Surface Mining Technology, Lovely Prakashan, Dhanbad, 1994
3) Das, S.K., Modern Coal Mining Technology, Lovely Prakashan, Dhanbad, 1994
4) Kennedy, B.A., Surface Mining – 2nd Edition, SME, New York, 1990 6. Hustrulid, W. and Kuchta, M., (eds).,
5) Cummings, A.B. and Given, I.V., SME Mining Engg. Hand book Vol.I and II, New York,1994
6) Proceedings of National Seminar on Surface Mining, IME Publications/ Calcutta, 1995
7) Fundamentals of Open Pit Mine Planning & Design, Elsevier, 1995.

MI 102

ROCK MECHANICS AND GROUND CONTROL

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To study about application of Rock Mechanics, Physico-Mechanical properties of rocks, non-destructive testing methods, time dependent properties of rocks.
- Design of different types of underground supports, etc.
- To study the theories of failure and approaches used for open pit and underground designs.

UNIT I

STRESS ANALYSIS **9**

Stress analysis in 2D and 3D, equations of equilibrium, Mohr's Circles, plane stress and plane strain condition, stress distribution in simple structures, Flexure of beams and rectangular plates,

UNIT - II

PROPERTIES OF ROCKS **9**

Physio-mechanical properties of rocks including tri-axial strengths and in-situ strengths and their application in the design of different types of excavations, rock indices viz. drillability index, caving index, etc. Time dependent properties of rocks and their application in structural design, static and dynamic elastic constants of rocks, rock mass classification methods. Selection excavator based on rock properties.

UNIT III

IN-SITU STRESSES AND THEORIES OF FAILURE **9**

In-situ stresses and instrumentation, drilling and blasting, measurement of stresses, strains, deformations, in-situ stress determination, strata monitoring in underground and opencast mines, mechanics a of drilling and blasting, blast vibration and its monitoring. Different theories of rock failure and their applications in design of mining structures.

UNIT IV **9**

DESIGN OF UNDERGROUND OPENINGS, SUBSIDENCE, ROCK BURST AND SLOPE STABILITY

Design of single and multiple underground openings, pillars including shaft pillar, scaling factors, mining subsidence, rock burst, design of slopes and spoil banks, slope stability in rock & soil and its analysis, slope monitoring and stabilisation techniques. Design of pillars including barrier and shaft pillars.

UNIT V

DESIGN OF MINE SUPPORTS **9**

Advances of mine supports, supports and bord and pillar and longwall workings, rock load assessment, design of different types of supports like conventional and non-conventional supports like shotcrete, fibre reinforced shotcrete, strata grouting, rock bolting, supports in tunnels and shafts.

TOTAL: 45 PERIODS

OUTCOME:

- The students will have detailed knowledge on the application of rock mechanics,
- Design of different types of underground openings and supports.
- Design, stabilization and monitoring of slopes, theories of subsidence and failure of rocks.

TEXT BOOKS:

1. Obert, L. and Duvall, W.I., Rock Mechanics and Design of Structure in Rock John Wiley and Sons Inc., New York, 1967.
2. Vutukuri, V.S., and Lama, R.D., Handbook on Mechanical Properties of Rocks, Vol. I, II, III and IV, Transtech Publication, Berlin, 1974/78.
3. Peng, S.S., Ground Control, Wiley Interscience, New York, 1987.

REFERENCES:

- Brady, B.H.G. and Brown, S.T., Rock Mechanics, Wiley Interscience, 1985.
- Hoek, E., and Brown, S.T., Underground Excavations in Rocks, Institute of Mining Metallurgy, London, 1980.
- Jumkis, A.R. Rock Mechanics, Transtech Publications, Berlin, 1983.
- Stacey, T.R. and Page, C.H., Practical Handbook for Underground Rock Mechanics, Transtech Publications, Berlin, 1986.
- Whittaker, B.N. and Reddish, D.J., Subsidence – Occurrence, Prediction and Control – Elsevier Science Publishers, the Netherlands, 1989.

MI 103

GEO-STATISTICS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To study various Geo-statistics techniques and their applications to mineral industry

UNIT - I

STATISTICS **9**

Theoretical models of Statistical distributions, viz. Normal (Gaussian), Lognormal, Binomial, Negative Binomial, Exponential and Poisson and their applications in resource evaluation; Characteristics and properties of Normal (Gausian) and Lognormal Probability Distributions, Graphical and Numerical Techniques of Model Fitting, Estimation of Distribution Parameters and their applications in Ore Evaluation. Geostatistical Concepts and Theories: Regionalized Variable Theory, Geostatistical Schools of Thought, viz. American, South African and French; Stationarity assumptions – Strict Stationarity, Second Order Stationarity and Intrinsic Hypothesis.

Overview of Deterministic and Probabilistic models of Estimation; Exploratory data analysis. Classical what, when and why of geo-statistics. Extension, estimation and dispersion variance; calculation by discretisation and auxiliary functions.

UNIT - II

GEOSTATISTICS **9**

Practice of semi-variogram modelling; practice of kriging - steps and procedure. Ordinary Kriging: definition, point/block estimation procedures, techniques of semi-variogram model fitting; Geo-statistical evaluation scheme; Effect of Nugget variance on kriged weights.

Brief capsule on Non-linear and Non-parametric Geo-statistics: Lognormal, Disjunctive and Multi-Gaussian, Indicator and Probability Kriging.

Concepts of Geo-statistics; Semi-variogram: definition, derivation and characteristics and properties. Derivation and solving kriging system of equations for point and block. Geostatistical conditional simulation – Theory and approach, techniques and applications with special reference to Simulated Annealing Simulation. Relation with Co-variogram characteristics; Calculation of Experimental Semi-variograms in One, Two and Three-Dimensions calculation procedures. Computation of semi-variograms; mathematical models of semi-variogram associated difficulties (Models with Sill and without Sill, Nested Models and Trend Models.) viz. anisotropy, non-stationarities, regularisation, presence of nugget effect and presence of trend.; Techniques of semi-variogram model fit.

UNIT - III

SAMPLING METHODS- 9

Theory and Concepts. Classical Statistical methods: Uni-variate and Bi-variate; Exploratory data analysis. Probability distributions: (i) Continuous distributions, viz. Normal (Gaussian), and Lognormal distributions and their fit to a sample distribution; (ii) discrete distributions, viz. Binomial, Negative binomial and Poisson distributions.

UNIT - IV

ADVANCED GEOSTATISTICS **9**

Practical difficulties associated with semi-variography, viz. anisotropy, non-stationarity, regularisation, misclassified tonnage; grade control plan. Presence of nugget effect and presence of trend. Extension, Estimation and Dispersion variances: definitions, methods of calculations and applications; Screen Effect.

UNIT - V

GEO-STATISTICAL APPLICATIONS: **9**

Optimisation of exploration drilling, calculation of mineral inventory, establishment of grade-tonnage relations, calculation and planning cut-off grade; misclassified tonnages; geo-statistical grade control plan.

Practical applications of Geo-statistics in geotechnical investigation, hydrocarbon exploration and reservoir modelling with case studies. Geo-statistical case studies of selected mineral deposits.

OUTCOMES

Students know about – Statistics- Theoretical models of Statistical distributions, viz. Normal (Gaussian), Lognormal, Binomial, Negative Binomial, Exponential and Poisson and their applications in resource evaluation; characteristics and properties of normal (gausian) and geostatistics, various sampling methods, details about advanced geostatistics and geo-statistical applications in the industry.

Text Books:

- Sarma, D.D. Geostatictics with Applications in Earth Sciences, Springer Publications, 2009.
- Journel, A.G. and Huijbregts, Ch. J., Mining Geostatictics, Academic Press, 1981.
- Andereson, F. Geostatictics by Example Approach using R.

MI 116

INSTRUMENTATION IN MINING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives: To learn about

- Electrical instruments
- Pressure and flow measurements
- Temperature and Environmental parameters measuring instruments
- Rock mechanics and ground control instruments

UINT I

ELECTRICAL INSTRUMENTS **9**

Basic Concepts: Sensitivity, range, reproducibility and accuracy, drift, absolute and relative measurements, error, environmental factors and planning for instrumentation. Accuracy, precision, resolution, sensitivity, linearity, span and range-Dynamic characteristics. Ammeters (MI & MC), Volt meters, Watt meters (Dynami), Energy Meters, Megger, Earth resistance measurement and thermocouples, Inclinometers

UINT II

PRESSURE AND FLOW MEASUREMENTS **9**

Unit of Pressure – Manometers- Different types, - Elastic type pressure gauges and sensors– Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge, deformation gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionisation gauge. Piezometer, Flow meters – Variable head type flow meter – Orifice plate – Venture tube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rotameter.

UNIT III

VIBRATION, HUMIDITY, VELOCITY AND LEVEL MEASUREMENTS **9**

Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer – Vibrometers – Geo-phones. Humidity – Hot wire electro type hygrometer – Dew cell – Electrolysis type hygrometer. Anemometer, Velometer, Pitot static tube, Sound level meter, microphone, Lux meter; Level measurements: – Float gauges - Displacer type – D/P methods -Bubbler system-Load cell – Electrical types – Conductivity sensors – Capacitive sensors . Differential pressure method and Hydrastep method -Solid level measurement.

UNIT IV

INSTRUMENTATION IN EXCAVATION

Introduction to various instruments in excavation, electronic and manual data generation Bore hole logging system, acoustic/ultrasonic instruments, ground penetrating radars Stress and strain, deformation, Instrumentation for performance monitoring. Field investigations

for selection and design of mechanical excavators and drilling systems. Data loggers, Automated data acquisition, analysis and interpretation.

UNIT V

INSTRUMENTATION IN ROCK MECHANICS **9**

Different types of Load cells, stress capsules, Flatjack, tape extensor meters, convergence indicators and recorders, borehole deformation gauges of different types, depth indicators. Seismic measurements, Application of instrumentation in rock mechanics in Mining**,** rock slope instrumentation.

TOTAL: 45 PERIODS

OUTCOME: Upon Completion of this subject, the students can able to explain different types of used in various mining activities

TEXT BOOKS:

1. De, N.K. and Sen, P.K. 'Electric Drives' Prentice Hall of India Private Ltd, 2002.
2. Subramaniam, V. 'Electric Drives' Tata McGraw Hill , New Delhi,2007
3. Dubey, G.K. 'Fundamentals of Electrical Drives' Narosa, Second Edition.
4. Morrris, A.S. Principles of Measurement and Instrumentation, Print ice-Hall of India Pvt., Ltd. New Delhi, 1999.
5. Doeblin, E.O. Measurement Systems Application & Design, Tata McGraw Hill Publishing Co., New. Delhi, 1999.
6. Whittaker, B. N. and Frith, R. C. (1990): Tunneling: Design, Stability and Construction, London: Institution of Mining and Metallurgy
7. Hoek, E and Brown, E.T. (1980):Underground Excavation in Rock, The Institution of Mining and Metallurgy, London
8. Bieniawski, Z. T. (1984):Rock Mechanics Design in Mining and Tunneling, Balkema.
9. John Dunnicliff Geotechnical Instrumentation for Monitoring Field Performance Lexington, Massachusetts

REFERENCES:

1. Bhattacharya, S.K., Singh, B. 'Control of Electrical Machines', New Age International Publishers,2002.
2. Bird, J. 'Electrical Circuit theory and technology' Elsevier, First Indian Edition, 2006.
3. Murthy, D.V.S. Transducers and Instrument and Instrumentation, Prentice Hall of India Pvt. Ltd. New Delhi.
4. Patranabir, D. Principle of Industrial Instrumentation, Tata McGraw Hill Publishing Co., New Delhi 1999.
5. Jain, R.K. Mechanical and Industrial Measurements, Khanna Publishing, New Delhi, 1999.
6. Liptak, B.G. Instrumentation Engineers Hand Book (Measurement), Chilton Book Co., 1994.

AC102

ENGLISH FOR RESEARCH PAPER WRITING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 0**

Course Objectives:

Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title

Ensure the good quality of paper at very first-time submission

UNIT – I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT – II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, useful phrases.

UNIT III

Sections of a Paper, Abstracts. Introduction Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT – IV

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, skills are needed when writing the Methods.

UNIT - V

skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. How to ensure paper is as good as it could possibly be the first- time submission

Suggested Readings:

- Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) Model Curriculum of Engineering & Technology PG Courses [Volume-I] [41]
- Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
- Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.
- Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

CE 100

RESEARCH METHODOLOGY IN CIVIL ENG.

No. of Credits	**: 3 Credits**
Instruction	**: 3 Periods per week**
Duration of University Examination	**: 3 Hours**
Semester End Evaluation	**: 70 Marks**
Continuous Internal Evaluation	**: 30 Marks**

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes:

- Differentiate the research types and methodology.
- Able to do literature survey using quality journals.
- Able to collect research data.
- Process research data to write research report for grant proposal.

UNIT – I **9**

Scientific Research: Definition, Characteristics, Types, Need of research. Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Defining and formulating the research problem-Meaning of a research problem, Sources of research problems, Criteria of a good research problem, Importance of literature review in defining a problem, Errors in selecting a research problem, Scope and objectives of the research problem. Approaches of investigation of solutions for the research problem.

UNIT – II **9**

Literature review-Source of literature, Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

Research design – Basic Principles, Need of research design, Features of good design, Important concepts relating to research design.

Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.

UNIT – III **9**

Execution of the research - Necessary instrumentations, Various data collection methods in Civil Engineering. Data processing and data interpretation. Data presentation and illustration.

Types of the reports–Technical reports and thesis; Different steps in the preparation – Layout, structure and language of technical writing; Writing research papers; Developing a Research Proposal, Common formats of the research proposals;
Oral presentation–Planning, Preparation, Practice, Making a presentation, Importance of effective communication

UNIT – IV **9**

Ethical issues - Research ethics, Plagiarism, Citation and acknowledgement
Patenting and development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT Patent Rights. Problems encountered by researchers in India.

UNIT – V **9**

Basics of statistics. Sampling and its types. Determination of sampling size. Sampling and non-sampling errors in statistics. Data: handling of data-significant figures & rounding. quality of data- precision & accuracy. Types of data.
Descriptive statistics: Summarization of Data- Measure of central tendency, Measure of central dispersion, Measure of symmetry.
Inferential statistics: Hypothesis of testing, Parametric (t-test & Analysis of variance) and Non-Parametric Tests. Univariate and Bivariate analysis; Correlational analysis.
Introduction to linear regression model and multi-linear regression models.
mathematical basis and introduction to SPSS

Suggested Reading:

- C.R Kothari, “Research Methodology, Methods & Technique”, New Age International Publishers, New Delhi, 2004.
- R. Ganesan, “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
- Ratan Khananabis and Suvasis Saha, “Research Methodology”, Universities Press, Hyderabad, 2015.
- Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & Engineering students”
- Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
- Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
- T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
- Y.P. Agarwal, “Statistical Methods: Concepts, Application and Computation”, Sterling Publishing Pvt. Ltd., New Delhi, 2004.
- Vijay Upagade and Aravind Shende, “Research Methodology”, S. Chand & Company Ltd., New Delhi, 2009.
- G. Nageswara Rao, “Research Methodology and Quantitative methods”, BS Publications, Hyderabad, 2012.

MI 109

COMPUTER APPLICATIONS IN MINING LABORATORY

AIM: To develop algorithms and programs on various mining related problems in basic programming languages.

Course Objectives:

- To study the computer programming for mining problems, mine ventilation network analysis, modelling of surface and underground workings using various software.

List of Experiments/ Programming:

1. Computer programming for mining problems like design of pillars / blast design / subsidence prediction.
2. Mine ventilation network analysis.
3. Database systems and analysis
4. Digitisation and scanning of mine plans
5. Ore body modelling.
6. Pit optimization.
7. Truck dispatch system optimization.
8. Production Scheduling for grade control
9. Digital Terrain modelling and Wire-frame modelling
10. Mine modelling
11. Slope stability analysis
12. Modelling of airflow through underground workings using finite element method.
13. Solving problems on excavation in rock and support
14. Patch test and stress around simple openings and comparing the numerical solution with closed form solution.
15. Modelling of typical open stope in metal mine and stability analysis of walls and pillars
16. Modelling of mechanical behaviour of pillars under different geo-mining conditions
17. Modelling of caving behaviour in strata
18. Modelling of slope
19. Modelling of supports in mines
20. Modelling of a hydroelectric cavern and gas oil storage cavern

MI 110

ADVANCED MINING GEOLOGY LAB

Course Objectives:

The geological concepts, processes, materials and phenomena are well understandable in the field rather than in the class room. An attempt in this direction is to show some important minerals and rocks, models of geological structures, and maps of different kinds in the laboratory.

Course Outcomes: At the end of the course, students will be able to

- Identify the various rock forming and ore forming minerals.
- apply various tools and techniques to measure water, air and noise pollution and adopt mitigative measures.
- Identify various structural deformities in open and under ground mines and will be able to take corrective measures to safe and optimal recovery of minerals.
- Understand the importance and uses of topographic and geological maps in the mining
- design survey and estimate the mineral reserves.

List of Experiments (Any 10)

1. Mineralogy: Identification and description of important rock-forming and ore minerals.
2. Petrology: Identification and description of rock specimens.
3. Distribution of important mineral resources of India and their origin.
4. Interpretation of a geological map/ metallogenic map of India.
5. Ore reserve estimation.
6. Calculating carbon footprints of a mining operation.
7. Thickness of strata by graphical method.
8. Applications of Remote Sensing and Drones in mine surveys/operation
9. Primary and secondary strutures applicable to mineral resources.
10. Understanding the implication of various primary and secondary structure on mineral production.
11. Applications of geophysical prospecting methods in exploration and exploitation of mineral resources.
12. Water pollution monitoring in mines: pH, DO, TDS measurement
13. Introduction to acid mine drainage treatment technology.
14. Air pollution monitoring in mines: Introduction to various particles and gasses emission monitoring techniques.
15. Noise pollution monitoring in mines: measuring techniques and mitigation measures
16. Dust monitoring in the mines.
17. Use and reclamation of mine overburden.
18. Strain and Stress: Measurement and Analysis.
19. Hydrogeological properties of rocks: Measurement and Analysis.
20. Measuring Dip and Strike of rock formations.

Suggested Reading :

1. *K.M. Gurappa, Structural geology Manual*
2. *B.S. Sathya Narayanaswamy Engineering Geology Laboratory Manual, Eurasia pub.*

MI 111

NUMERICAL MODELLING IN MINING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To study the finite element methods, finite difference methods and boundary element methods
- To understand the practical applications of numerical methods in mining field

UNIT I

INTRODUCTION TO ELASTIC AND PLASTIC MODELS **9**

Fundamentals, elastic, plastic, homogeneous and isotropic, non-linear elastic and elastoplastic models. Need for numerical modelling in design of excavations in mines; Domain and boundary conditions; Discretisation of domain and boundary; Methods of numerical simulation for excavations in mining.

UNIT II

FINITE DIFFERENCE METHODS **9**

Concept, formation of mesh element, finite difference patterns, solutions, application to mining. Commercial Softwares for application in mining.

Explicit finite difference method; Finite difference equation; Mechanical damping, mechanical time-step determination, solution stability, advantages and their limitations. Non-linear solution methods Introduction to Numerical Modelling Packages: Strand – 7 and FLAC.

UNIT III

FINITE ELEMENT METHODS **9**

Concept, discretisation, element configuration, element stiffness, Assembling elements to form a structural stiffness matrix; Imposing boundary conditions and solving structural equations Elements on assumed displacements, constant strain triangle, isoparametric formulation, advantages and their limitations., two and three dimensional solutions, linear and non-linear analysis, applications in geomechanics; simulation of joints in strata. Commercial Software for application in mining.

UNIT IV

BOUNDARY ELEMENT METHOD **9**

Concept, discretisation,formulation, merits, demerits and limitations, different methods of solution for isotropic and infinite media. Commercial Softwares for application in mining.Boundary Element Method: Introduction, formulation, advantages and their limitations.

UNIT V

PRACTICAL APPLICATIONS IN MINING AND ROCK MECHANICS 9

Practical Applications in stress analysis, slope and dump stability, subsidence prediction, pillar design, rock burst, different types of mine supports, etc.

Constitutive modeling and their uses: Mohr's Coulomb Plasticity model for simulation of rock failure, Interfaces to simulate the bedding planes, Simulation of support in rock: bolts, props and lining.

TOTAL: 45 PERIODS

OUTCOME: The students will get the concept about finite element models, methods and boundary elements method and its practical applications in mining and rock mechanics.

REFERENCES

- Desai, C.S. and Abel, J.F., Introduction to the finite Element Method, Van Nostrand Riehokl Co., New York, 1983.
- Zienkiewicz, O.C., The Finite Element Method in Engineering Science, Tata McGraw Hill 1972.
- Segerlind, L.J., Applied Finite Element Analysis, John Wiley and Sons, New York, 1987.
- Mukhopadyay, M., Matrix Finite Element – Computer and Structural Analysis, Oxford and IBH Publishing co., 1984
- Brown, E.T., (Ed) Analytical and Computational Methods in Engineering and Rock Mechanics, Allen and Unwin, London, 1987.

MI 112 **ROCK EXCAVATION ENGINEERING**

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To understand the rock mechanics, rock cutting technology, rock cutting tools and rock excavating machine.

UNIT I

INTRODUCTION **9**

Concepts, historical developments in rock excavation, systems, factors affecting the rock fragmentation, mechanism of rock breakage and fracture; their application to rock fragmentation methods for rock fragmentation – explosive action, cutting, ripping and impacts. Scope and importance of rock excavation engineering in mining and construction industries; physico-mechanical and geotechnical properties of rocks, selection of excavation method. Rock breaking processes: Primary, Secondary and Tertiary, Energy consumption computations.

UNIT II

ROCK MECHANICS **9**

Rock properties related to machining process; application of compressive, tensile and multiaxial strengths, index tests and abrasivity, anisotropy, elasticity, porosity, laminations, bedding and jointing in rock fragmentation process.

UNIT III

ROCK CUTTING TECHNOLOGY **9**

Mechanism of drilling – rotary, percussive, rotary, rotary percussive, mechanics of rock machining, theory of single tool rock cutting, crack initiation and propagation, rock excavation by cutting action – picks, discs, roller cutters water jet cutting, methods of evaluation of drillability and cuttability of rocks. Evaluation of drill performance; mechanism of bit wear; bit selection; economics of drilling.

UNIT IV

ROCK CUTTING TOOLS **9**

Rock cutting tool materials, different types, relative applications and their choice, tool shape and size, specific energy consumption, tool wear, effect of operational parameters on tool performance, maintenance and replacement of cutting tools of excavating machines.

Theories of rock tool interaction for surface excavation machinery rippers, dozers, scrapers, BWE, continuous surface miners, auger drills; theories of ploughs, shearers.

UNIT V

ROCK EXCAVATING MACHINES **9**

Excavating machines, principles, operation, applicability and technical indices of road headers, TBM'S coalface machines and bucket wheel excavators.

Recent Developments in rock excavation machinery.

TOTAL: 45 PERIODS

OUTCOME:

The students will get familiarity about rock mechanics properties, rock cutting technology and excavating machines.

REFERENCES

- Cummings, A.B. and Given, I.V., SME Mining Engg. Vol. I and II, Society of Mining Engineers, America, 1992.
- Hartman, H.L., Introductory Mining Engineering, John Wiley and Sons, New York, 1987.
- Chugh, C.P., Diamond Drilling, Oxford-IBH, 1984.
- Clark, G.B., Principles of Rock Fragmentation, John Wiley and Sons, New York, 1987

MI 113

SURFACE MINE ENVIRONMENTAL ENGINEERING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To study the physics of mechanical ventilators and the parameters governing their performance.
- To study various methods of ventilation data collection.
- To study about mine illumination, pollution and ecological systems.

UNIT I

INTRODUCTION **9**

Goals, strategies and tools for environmental management – systems approach to environmental management – environmental guideline – National Policies on environment with respects to mining activities – Global and Local environmental issues – resource degradation – desertification – Industrialization, Objectives of Sustainable Development. Structure of the atmosphere – ozone layer depletion – Acid rain – Green house gases and global warming Ambient Air quality and emission standards, Air quality Sampling and monitoring, Dispersion of air pollutants.

UNIT II

ENVIRONMENTAL POLLUTION - I **9**

Environmental Pollutants due to surface – Air, Water, Noise, Sources and Classification of pollutants including dust and their effect on human health, Sources, hazards, sampling and analysis, standards, instrumentation and measurement of pollutants including dust, Air born dust modeling, Control and preventive measures for air pollution including for dust, , Water pollution standards, Noise standards – Measurement – Noise Impact Index assessment, Control and preventive measures for water, noise pollution. Pollution due to blast and equipment vibrations their monitoring, prevention and control.

UNIT III

ENVIRONMENTAL POLLUTION - II **9**

Land pollution, land for alternation dealing with mind out land , re-vegetation, tailing management, tailing dams, method and construction, land use plan, Mine closure planning. Textural classification and properties of soil. Impact of pollution on human health, miner's diseases and their social impact.

UNIT IV

ENVIRONMENTAL MANAGEMENT **9**

Environmental quality objectives, Emission and ambient standards – Minimum National standards – International environmental standards – ISO 14000 – EIA Notification – Sitting of Industries – Environmental management plans, Environmental impact assessment, Environmental management system audits, Environmental economics – Principles of cost

benefit analysis – Valuing the Environment – Environmental Accounting, Environmental administration- training awareness and competence, Mine subsidence, its prediction and control.

UNIT V

ENVIRONMENTAL LEGISLATIONS **9**

Environmental laws, the Environmental (Protective) Act, 2004, The Water Act (1974), The Air act (1981), The Forest Act 1927, The forest conservation act 1980, Power and responsibilities of regularity agencies and occupation consent to establish and operate wild life protection act and rules , Environmental clearance procedure for a mining Project.

OUTCOME:

The students will have knowledge on mechanical ventilators, influencing parameters and various methods of data collection. They will also know about illumination, pollution and ecological systems.

TEXT BOOKS:

- Manahan S.E. Environmental Science and Technology.
- Mackenthun, K.M. Basic Concepts in Environmental Management, Lewis Publications, London, 1998.

REFERENCES:

- Noel de Nevers, Air Pollution Control Engg., McGraw Hill, New York, 1995
- Anjaneyulu,Y. Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India, 2002.
- Nick Hanley, Jaison F. Shogren and Ben White. Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi, 1999.
- Roger Perman, Yue Ma and James McGilvray. Natural Resources and Environmental Economics, Second edition, Addision Wesley Longman Ltd, Singapore, 1997.
- Christopher Sheldon and Mark Yoxon, Installing Environmental Management System – a step by step guide, Earthsecan Publications Ltd, London, 1999.
- Lee Kuhre, ISO 14001 Certification –Environmental Management Systems, Prentice Hall, USA, 1995.
- Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India, Oxford University Press, New Delhi. (2001)
- Gregor I. Mcgregor. Environmental Law and Enforcement, Lewis Publishers, London, 1994.

MI 114 MODERN SURVEYING TECHNIQUES

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To understand the working of Total Station equipment and solve the surveying problems.
- To introduce the concepts of Space Borne, Air Borne and Terrestrial LASER
- Scanners for Topographic Mapping

UNIT I

FUNDAMENTALS OF TOTAL STATION AND ELECTROMAGNETIC WAVES 9

Types and working principles of Machines, Methods of Measuring Distance, Basic Principles of Total Station, Historical Development, Classifications, applications and comparison with conventional surveying. Classification - applications of Electromagnetic waves, Propagation properties, wave propagation at lower and higher frequencies- Refractive index (RI) - factors affecting RI. Care and Maintenance of total stations.

Electro-optical system: working principle, Sources of Error, Infrared and Laser Total Station instruments. COGO functions, offsets and stake out-land survey applications.

UNIT II

SATELLITE, GPS SYSTEM and data processing 9

Basic concepts of GPS, GNSS, IRNSS and GAGAN - Different segments - space, control and user segments - satellite configuration – GPS signal structure, Anti Spoofing and Selective Availability - GPS receivers. Concepts of rapid, static methods with GPS - semi Kinematic and pure Kinematic methods -satellite geometry & accuracy measures - applications.

UNIT III

MINE AND CADASTRAL SURVEYING 9

Reconnaissance – Route surveys for highways, railways and tunnels –Mine surveying Equipment – Weisbach triangle – Tunnel alignment and setting out – Transfer of azimuth – Gyro Theodolite – Shafts and audits - Cadastral survey- Legal – Real – Tax cadastre – Land record system – Settlement procedure – deformation studies. Mine plan preparation - mapping process - use of mapping softwares, VAVIks mapping.

Route surveys of water ways, Hydrographic survey Tides – MSL – Sounding methods – Three point problem – River surveys – Measurement of current and discharge.

UNIT IV

AIRBORNE LASER SCANNERS 9

Airborne Topographic Laser Scanner – Ranging Principle – Pulse Laser and Continuous Wave Laser – First Return and Last Return – Ellipsoidal and Geoidal Height - Typical parameters of a Airborne Laser Scanner (ALS) – Specifications of Commercial ALS –- Components of ALS -

GPS, IMU, LASER Scanner, Imaging Device, Hardware and Software. Merits of ALS in comparison to Levelling, echo sounding, GPS levelling, Photogrammetry and Interferometry

UNIT V

DATA ACQUISITION, PRE and Post PROCESSING 9

Various Scanning Mechanism – Synchronization of GPS, IMU and ALS Data - Reflectivity of terrain objects – Laser Classification – Class I to Class IV Laser – Eye Safety. Ground Point filtering – Digital Surface Model and Digital Elevation Model. Overview of LIDAR Applications in various domains - 3D models – Corridor Mapping Applications – Forestry Applications. Terrestrial Laser Scanners (TLS) – Working Principle – Commercial TLS Specifications – Applications of TLS, Drone based Mapping - derivatives from drone surveying.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the student will be able to understand

- various techniques available for surveying and mapping along with working principles, functioning and applications of total station and GPS instruments
- Propagation of EMR through atmosphere and corrections for its effects.
- Concepts of ALTM and working principle
- Available types of ATLM sensors and components of ALTM system. Process of data acquisition, data processing and possible applications. The fundamentals of terrestrial scanners and their applications.

TEXTBOOKS:

- Satheesh Gopi, Rasathishkumar, N.Madhu, – Advanced Surveying, Total Station GPS and Remote Sensing – Pearson education, 2007 ISBN: 978-81317 00679 52.
- Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 3rd Edition, 2004.
- Jie Shan and Charles K. Toth, Topographic Laser Ranging and Scanning – Principles and Processing, CRC Press, Taylor & Francis Group, 2009.

REFERENCES:

- Rueger, J.M. Electronic Distance Measurement, Springer-Verlag, Berlin, 1996.
- Michael Renslow, Manual of Airborne Topographic LiDAR, The American Society for Photogrammetry and Remote Sensing, 2013.
- R.Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.

MI 115

LONGWALL MINING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To pioneer the history of longwall mining and its development stages
- To understand the extraction, support and transport on a longwall face
- To learn ventilation methods and strata monitoring instruments

UNIT I

PLANNING **10**

History of longwall mining and its development, techno-economic consideration of the modified longwall retreat panels, longwall advance panels with caving method and stowing method, design of gate roadways and their size disposition, layout of panels, production and manpower planning, sublevel caving systems for thick seams, caving system in thin seams, multi-slice longwall mining, application of longwall mining for steep seams, longwall caving in metal mines.

UNIT II

SUPPORTS **10**

Types of supports used in longwall mining in the past and present, design of powered supports for different situations, longwall face end problems, supports in longwall gate roadways during drivage and extraction, pressure distribution around a moving longwall face, caving of thick seams and thin seams. Main roof fall, local fall and induced roof wall, floor heaving, precautions during main fall and surface subsidence.

UNIT III

EXTRACTION AND TRANSPORT ON A LONGWALL FACE **10**

Methods of mining coal on longwall faces, machines – shearers, ploughs etc., methods of cutting and face advancement, stables and sumping, gate road pillar extension. Mode of transporting coal or ore in longwall face and machinery used. Shortwall Mining – a modified longwall mining. Remotely operated longwall faces. Shifting of longwall equipment.

UNIT IV

DEVELOPMENT AND WORKING OF LONGWALL FACES **8**

Methods of driving gate roadways, choice of selection of machinery, road headers and dinters, special problems associated with working of longwall faces - faults, roof caving, face spalling, overburden movement, subsidence control, hydraulic stowing, dealing with spontaneous heating while working thick seams in coal.

UNIT V

ENVIRONMENT AND ANCILLARY **7**

Methods of ventilating longwall faces and gate roadways. Methane control, dust control and noise control, monitoring at longwall faces. Assessment of cost of ventilation. Electric and 103 hydraulic circuits. Surface and ground water effects. Strata monitoring with instruments.

TOTAL: 45 PERIODS

OUTCOME:

The students will have better understanding about mine planning, methods of working, development of longwall face, support systems, methods of ventilating longwall faces and transport system on a longwall face.

TEXT BOOKS:

- Peng , S.S., Longwall Mining, 2nd Edition, John Willey and Sons, New York, 2006
- Peng, S.S., Coal Mine Ground Control, 3rd Edition, John Willey and Sons, New York, 2008.
- Singh, R.D., Principles and Practices of Modern Coal Mining, New Age International, 1997.
- Singh, T.N., Underground Winning of Coal, Oxford IBH Publishers, 1999.

REFERENCES:

- Mathur, S.P., Mining Planning for Coal, M.G. Consultants, Bilaspur, 1999
- Singh T.N., Dhar, B.B. Thick Seam Mining, problems and Issues, Oxford & IBH Publishers, 1992.
- Das S.K., Modern Coal Mining Technology, Lovely Prakashan, Dhanbad, 1994.
- Longwall Mining in Company Seminar – Proceedings – The Singareni Collieries Co. Ltd., 1990.

CE 311

GROUND IMPROVEMENT TECHNIQUES

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To understand the objectives, necessity and scope of ground improvement techniques
- To learn different methods of in-situ densification of cohesive, cohesionless soils
- To learn the classification, functions and applications of Geosynthetics in ground improvement
- To learn the process of identification of necessity for ground improvement, finding alternative methods and recommendation of the ideal technique through case studies

Course Outcomes

1) Ability to understand the necessity of ground improvement and potential of a ground for improvement
2) To gain comprehensive understanding about the improvement of in-situ cohesive soils as well as Cohesion less soils
3) Competence to analyze an in-situ ground, identification of ground improvement techniques feasible, selection of the ideal method, its planning , design, implementation and evaluation of improvement level

UNIT – I **9**

General : Formation of rock, soils and soil profiles, soil distribution in India and other countries - marine, black cotton soils (expansive)., lateritic, alluvial, desert soils peat etc., factors affecting the alteration of ground after formation – natural and man-made – reclaimed soils – methods of geotechnical processes.

UNIT – II **9**

Compaction methods: moisture density relations – compactive efforts – field methods – surface compaction, deep compactions- vigor compaction methods, vibro-probes, stone columns, sand compaction, stone column piles, selection of methods – quality control – specifications for compaction process for solving field problems.

UNIT – III **9**

Drainage methods: seepage, ground water seepage control – filter requirements methods of dewatering – well point methods of discharge computations – design of steps for

dewatering – design of well screens – selection of pumps and accessories – deep bored wells.

Pre-compression methods: compressibility and consolidation properties of soils estimation of rate of consolidation settlements – accelerating methods – monitoring compressions – design of vertical drains – consolidation by electro osmosis and vacuum compression methods.

UNIT – IV **9**

Grouting and injection methods: principles, design methods, selection of methods and requirements. Aspects of grouts, types of grouts and chemical applications, seepage control, solidification and stabilization – equipment and accessories used – quality control – specifications for achieving satisfactory results.

UNIT – V **9**

Stabilization methods: mechanical, cement, lime, chemical methods of stabilization of soils – use of admixtures – polymers – geosynthesis – reinforcements thermal slurry trenches, void filling – prewetting – improving rock stability methods – exercise quality control to achieve desired results.

TOTAL: 45 PERIODS

Suggested Reading:

- J.E. Bowles – Foundation Design & Analysis.McGraw-Hill Edition 1995.
- Ground improvement techniques by P. Purushottam Raj, Laxmi Pub., 1999.
- F. S. Fang Handbook of Foundation Engg. CBS Pub., 1985.

MI 116

RELIABILITY ENGINEERING

Instruction	**: 3 Periods / Week**
Duration of Univ. Examination	**: 3 Hours**
SEE	**: 70 Marks**
CIE	**: 30 Marks**

UNIT I **9**

Discrete and Continuous Random Variables - Binomial, Poisson, Normal, Lognormal, Exponential and Weibull distributions - Causes of failure - Failure rate and Failure density - Reliability and MTTF.

UNIT II **9**

Maintainability and Availability - MTBF and MTTR - Reliability block diagram - Series and parallel systems -Redundancy - Standby system with and without imperfect switching device - r out of n configuration.

UNIT III **9**

Morkov models - Reliability models of single unit, two unit, Load shared and Standby systems - Reliability and availability models of the above systems with repair. Frequency of failures - State transition matrices and solutions - Accelerated life testing.

UNIT IV **9**

Chi-square distribution - Confidence limits for Exponential and Normal distributions - Applications of Weibull distribution and ML estimates - Goodness of fit test - Preventive maintenance - Reliability and MTTF - Imperfect maintenance - Age replacement policy.

UNIT V **9**

Power system reliability – Outage definitions - Morkov model of a generating plant with identical units and un-identical units - Capacity outage probability table – Cumulative frequency -LOLP and LOLE.

TEXT BOOK:

- Charles E. Ebeling, An Introduction to Reliability and Maintainability Engineering, McGraw Hill International Edition, 1997.
- Endrenyi, Reliability Modelling in Electrical Power Systems - John Wiley & Sons, 1980.
- Roy Billington and Ronald N.Allan, Reliability Evaluation of Engineering Systems Plenum Press, NewYork,1992.
- Roy Billington and Ronald N.Allan, Reliability Evaluation of Power Systems, Plenum Press, NewYork, 1996.

MI 117

FINITE ELEMENT ANALYSIS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

UNIT I

INTRODUCTION **9**

Background - General description of the method - Analysis Procedure. Node numbering – Mesh generation - Linear constitutive equations - Plane stress, Plane strain and axisymmetric cases of elasticity - Energy principles - Variational methods – Raleigh-Ritz method – Galerkin Method.

UNIT II

ONE DIMENSIONAL PROBLEMS **9**

Finite element modelling – Coordinates and shape functions – Linear and quadratic elements - Applications to axial loadings of rods – Extension to plane trusses – Bending of beams Element, Finite element formulation of stiffness matrix and load vectors – Assembly for global equations – Boundary conditions.

UNIT III

TWO DIMENSIONAL PROBLEMS **9**

Convergence requirements - Constant Strain Triangular (CST) Element – Rectangular Element -Finite element modelling - Element equations, Load vectors and boundary conditions – Assembly - shape functions from Lagrange and serendipity family— Application to heat transfer.

UNIT IV

ISOPARAMETRIC FORMULATION **9**

Introduction – Coordinate Transformation –Basic theorem of Isoparametric concept – Uniqueness of mapping – Isoparametric, Subparametric and Superparametric elements – Assembling Stiffness matrix – Numerical Examples.

UNIT V

APPLICATIONS **9**

Application of displacement finite elements to the analysis of simple problems (one and two dimensional cases) in the area of structural mechanics. Computer Programs: Development of computer programs for an axial and beam bending elements – Programming and use of

computer packages for design of underground excavations, mining structures, slope and dump stability, design of supports, etc..

Total: 45 Periods

OUTCOMES:

Upon completion of this course, the students can able to understand differentmathematical Techniques used in FEM analysis and use of them in Structural and thermal problem.

TEXT BOOK:

1. J.N.Reddy, “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGrawHill, 2005.

REFERENCES

- Krishnamoorthy, C.S, Finite Element Analysis Theory & Programming, McGraw-Hill, 1995.
- Desai C.S and Abel,, J.F., Introduction to Finite Element Method, Affiliated East West Press Pvt. Ltd., New Delhi, 2000
- Chandrupatla T.R., and Belegundu A.D., “Introduction to Finite Elements in Engineering”, Pearson Education, 2011, 4th Edition.
- Bhavikkatti, S.S. Introduction to Finite Element Analysis –Newage International (P) Limited Publishers, New Delhi, 2011.
- Seshu, P., Textbook of Finite Element Analysis. New Delhi: Prentice-Hall of India, 2006.
- Bathe. K.J., "Finite Element Procedure", Prentice Hall of India, New Delhi, 2006.
- Logan, D.L., “A First course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002
- Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.
- Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butter worth Heinemann, 2004
- Chandrupatla, R & Belagundu, A.D. “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div., 1990.
- Cook R.D., “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons Inc., New York, 1989.
- Zienkiewicz, O.C., Taylor, R.L. and Zhu, J.Z. “The Finite Element Method: Its Basics and Fundamentals”, Seventh Edition, Volumes 1 &2, Elesevier Publications, 2013.

AC105

PERSONALITY DEVELOPMENT

Instruction	**: 2 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 0**

Course Objectives:

Students will be able to:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT – I

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

UNIT – II

Approach to day to day work and duties.

- Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

UNIT – III

Statements of basic knowledge.

- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model.

- Shrimad Bhagwad Geeta: Chapter2-Verses 17,
- Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

Course Outcomes:

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading

- "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
- Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
- Rashtriya Sanskrit Sansthanam, New Delhi.

AC106

STRESS MANAGEMENT BY YOGA

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 0**

Course Objectives:

- To achieve overall health of body and mind
- To overcome stress

UNIT – I

Definitions of Eight parts of yog. (Ashtanga)

UNIT – II

Yam and Niyam: Do`s and Don'ts in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT – III

Asan and Pranayam

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

Course Outcomes:

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

Suggested reading

- 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
- "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

AC107

CONSTITUTION OF INDIA

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 0**

Course Objectives:
Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT – I
History of Making of the Indian Constitution: History, Drafting Committee (Composition & Working)
Philosophy of the Indian Constitution: Preamble Salient Features

UNIT – II
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT – III
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

UNIT – IV
Local Administration: District's Administration head: Role and Importance. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments). Village level: Role of Elected and Appointed officials. Importance of grass root democracy

UNIT – V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Course Outcomes:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading

- The Constitution of India, 1950 (Bare Act), Government Publication.
- Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
- M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015

MI118 **Core-V/ MC**

Mini Project

Lab-III **CE 131**

Geo-Technical Engineering Laboratory

Lab-IV/ Seminar **MI 161**

Seminar

MI 119

ADVANCED COAL MINING AND MECHANIZATION

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To introduce the recent trends of level of mechanisation for coal face
- To understand the various advanced methods of coal mining

UNIT I

COAL FACE MECHANISATION **8**

Recent Trends, mechanised bord and pillar mining, case studies.

UNIT II

MINING OF THICK SEAMS **8**

Problems, past experiences in India, current methods, mining of thick, contiguous, and steep seams

UNIT III

HYDRAULIC MINING **9**

Applicability, operating parameters, equipment, layouts, Indian experience. Computer applications such as remote control and environmental monitoring in hydraulic mining.

UNIT IV

LONGWALL MINING **10**

Powered supports, development of powered supports, their types and designs, selection for different conditions, last drivages for longwall panelling, remotely operated powered support and longwall faces, Indian experiments, salvaging in longwall.

UNIT V

UNDERGROUND COAL GASSIFICATION **10**

Scope, application, methods of gasification, design of gasification plants, coal bed methane. Environmental monitoring techniques and computer applications in coal gasification techniques.

OUTCOME:

The students will have good exposure about the various advanced methods of coal mining with the knowledge about advanced coal face mechanization.

REFERENCES:

- Das S.K., Modern Coal Mining Technology, Lovely Prakashan, Dhanbad, 1994
- Singh, T.N., and Dhar, B.B. Thick Seam Mining, Problems and Issues, Oxford & IBH Publishers, 1992
- Mathur, S.P., Mining Planning for Coal, M G Consultants, Bilaspur, 1993
- Peng S.S. and Chiang, H.S., Longwall Mining, John Willey and Sons, New York, 1992
- T.N. Singh, Underground Winning of Coal, Oxford IBH Publishers, 1999

- R.D. Singh, Principles and Practices of Modern Coal Mining, New Age International, 1997

MI 120

MINE SYSTEMS ENGINEERING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- To know basic of system engineering concept and analysis
- To study the various techniques of operations research, simulation and network analysis

UNIT I

INTRODUCTION **9**

Introduction to systems engineering, systems concept and analysis, models in systems analysis, tools and methodology of system analysis.

UNIT II

OPERATIONS RESEARCH **9**

Introduction to operations research, introduction to linear programming, application to mineral industry.

UNIT III

SIMULATION TECHNIQUES **9**

Introduction to Monto-carlo sampling and deterministic simulation of different mining subsystems and total system, simulation application for equipment selection and production scheduling.

UNIT IV

NETWORK ANALYSIS **9**

Network analysis, monitoring and control of developmental activities in mining project by CPM and PERT.

UNIT V

MISCELLANEOUS **9**

Inventory of mineral resources, basic models and optimisation, introduction to statistical decision theory and its application in mineral industry.

TOTAL: 45 PERIODS

OUTCOME: The students will learn the concept of system engineering and applicability in mining field.

REFERENCES

- Syal, I.C., and Gupta, B.P., Computer Programming and Engineering Analysis, A.B., Wheeler and Company, Madras 1986.
- Anon., Management by Network Analysis, The Institution of Engineers (India), 1976.
- Rao, S.S., Finite Element Methods in Engineering, Pergamon Press, 1982.

- Cummings, A.B., and Given I.V. SME Mining Engg., Handbook Vol I and II, SME-41 ME, Inc, New York, 1973.

CE 203

GROUNDWATER ENGINEERING

Instruction	**: 3 periods per week**
Duration of University Exam	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- A pathway to understand the basic physical principles of groundwater flow, differential equations, boundary condition and groundwater quality.
- Knowledge of various aspects of recharge of groundwater.
- Exposure to use the numerical solutions to solve problems with complex realistic situations.

UNIT-I **9**

*Introduction:*Ground water in hydrologic cycle, Distribution of subsurface water, ground water potential, occurrence of groundwater in hydro geologic formations, components of groundwater studies, Darcy's law and its validity.

Governing equations of groundwater flow in aquifers: 3-D Ground water flow equations in Cartesian and polar coordinates, equations for steady radial flow into a well in case of confined and unconfined aquifers, equations for effect of uniform recharge in a fully penetrating unconfined aquifer, well flow near aquifer boundaries.

UNIT-II **9**

Equations for unsteady radial flow into a well in case of confined aquifer, determination of Storage coefficient and Transmissibility(S and T) by Theis's graphical method, Cooper-Jacob's and Chow's method. Image well theory, partial penetration of wells, multiple well system.

UNIT-III **9**

Artificial recharge of aquifers: Introduction, current trends in artificial recharge, spreading methods, injection wells, technical feasibility and economic viability.

Geophysical methods in groundwater Exploration: surface geophysical methods: electrical resistivity method, seismic method, magnetic method, determination of aquifer thickness.

UNIT-IV **9**

Quality of groundwater and seawater intrusion in coastal aquifers: Dissolved constituents in groundwater and their effects, fluctuations in groundwater, mechanism of salt water intrusion, Ghyben-Herzberg relation, slope and shape of the interface, prevention and control of seawater intrusion, case studies involving sea water intrusion.

UNIT-V **9**

Models in ground water analysis: Major applications of ground water models, sand models, viscous fluid models, membrane models, thermal models, electric-Analog models, numerical modeling of ground water systems.

Outcomes:

- Knowledge of groundwater hydrology and hydraulics of the movement of water in aquifers to manage groundwater resources.
- Use of knowledge and skill for the enhancement of human welfare.
- Ability to deal with more realistic situations to solve problems pertaining to groundwater quality.
- Conduct simulation studies for future state of groundwater systems, optimal protection and rehabilitation strategies

Suggested Reading:

- Ven-Te-Chow, (1964) 'Hand book of Applied Hydrology', McGraw-Hill Book Company, New York.
- Todd, D.K. (1980) 'Groundwater Hydrology', John Wiley and Sons, New York.
- Karanth, K. R. (1987) 'Groundwater Assessment, development and Management', Tata Mc Graw – Hill publishing company New Delhi.
- Raghunath H.M,(1982), 'Ground water' Wiley Eastern Ltd, New Delhi.
- Wang Herbert. F. and Anderson Mary. P. (1995), 'Introduction to groundwater modeling; FDM and FEM', Academic Press, New York.
- Rastogi, A.K. (2007) 'Numerical Groundwater Hydrology', Penram International publishing (India) Pvt Ltd.

CE 215

MODELS OF AIR AND WATER QUALITY

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- Description of the concepts of water and air pollution
- Exposure to the principles of modeling and their application to water bodies
- An overview regarding reservoir sedimentation

UNIT – I **9**

Introduction: Water pollutants and their sources Stream sampling – hydrological factors affecting the stream self – purification. Steady state conservative system, steady state with non-conservative pollutants.

UNIT – II **9**

Stream pollution modeling concepts: Measurement of BOD – Streeter Phelp's equation – Effect of temperature on BOD, Kinetic reaction rate – Stream re-aeration. Analysis of DO Sag curve by Streeter – Phelps equation method, statistical method.

UNIT – III **9**

Water Quality of Lakes and Reservoirs: Mass balance model, Phosphorus model, Thermal stratification, Eutrophication of lakes.

Reservoir sedimentation: Determination of sediment yield, measurement of suspended load, Bed load estimation by empirical methods, control of sedimentation

UNIT – IV **9**

Air Pollution: Sources and effects, scales of concentration, classification and properties of air pollutants effects of air pollution and air pollution standards, dispersion of air pollutants. Meteorological aspects of air pollution and atmospheric stability

UNIT –V **9**

Plume behavior, modeling of air pollution: Gaussian plume model – determination of maximum ground level concentration due to elevated source pollutants. Limitations of Gaussian model, effective stack height concept and estimation of plume rise**.**

Outcomes:

- Capable of analyzing stream water and air quality issues along with the modeling techniques and standards
- Capable to estimate the reservoir sedimentation problems and apply various methods to control them

Suggested Reading:

- Keily Gerard (1998), 'Environmental Engineering' McGraw-Hill International Publishers, London.
- Fischer, H.B., E. John List, Robert C.Y. Koh, Jorg Imberger, and Norman H. Brooks(1979), 'Mixing in Inland and Coastal Waters' Academic Press Inc., New York.
- Nelson Leonard Nemerow (1974), 'Scientific Stream Pollution Analysis' McGraw-Hill Publishers.
- Wurbs, R. A. and James, W.P.(2002), 'Water Resources Engineering', Prentice-Hall of India, New Delhi.
- Graf, W.H. (1971), 'Hydraulics of Sediment Transport', McGraw-Hill Book company, New York
- Yalin, M.S. (1997), 'Mechanics of Sediment Transport', Pergaman Press, Oxford.

Open Elective

Industrial Safety
Business Analytics
Waste to Energy

Core-VI/ MC

MI 381 Major Project Phase-I

SEESTER IV

Core-VII/ MC MI 382 Major Project Phase-II